U.S. Fish and Wildlife Service

DRAFT ENVIRONMENTAL ASSESSMENT

APPROVAL OF TUNGSTEN-BRONZE-IRON SHOT FOR HUNTING WATERFOWL AND COOTS

DIVISION OF MIGRATORY BIRD MANAGEMENT

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APPROVAL OF TUNGSTEN-BRONZE-IRON SHOT AS NONTOXIC FOR HUNTING WATERFOWL AND COOTS

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November 2003

ABSTRACT

- In October 2003, International Nontoxic Composites, Inc., of Ontario, Canada applied for permanent approval of Tungsten-Bronze-Iron (TBI) shot, a 51.1% tungsten/44.41% copper/3.9% tin/0.6% iron formulation, as a nontoxic shot type.

- The tungsten, tin, and iron in TBI shot have already been approved in other shot types in proportions similar to those seen in TBI shot. Of concern in this application is the copper in the bronze alloy in TBI shot.

- We reviewed the results of acute toxicity testing and environmental fate information for the tungsten-bronze-iron shot for hunting waterfowl and coots. We determined that TBI should raise no concerns about deposition in the environment.

- The data on the shot and the metals in it indicate that the shot is nontoxic when ingested by waterfowl, and that it does not poses a significant danger to migratory birds, other wildlife, or their habitats.

- We conclude that TBI shot should be approved for use and that 50 CFR 20.21 should be changed accordingly.

INTRODUCTION

In October 2003, International Nontoxic Composites, Inc., (INC) of Ontario, Canada applied for permanent approval of Tungsten-Bronze-Iron (TBI) shot, a 51.1% tungsten, 44.41% copper, 3.9% tin, and 0.6% iron formulation, as a nontoxic shot type. INC estimated that sales of TBI shotshells might result in annual deposition of 216,000 kg (≈476,000 pounds) of TBI shot in waterfowl hunting areas.

We have reviewed the data on toxicity and environmental fate information for TBI shot for hunting waterfowl and coots. In this document we review those findings and propose two alternatives for use of the shot.

PURPOSE

The purpose of this assessment is to consider the potential use of the TBI shot for waterfowl hunting. Deposition of shot and release of shot components in waterfowl hunting locations are potentially harmful to many organisms. Since the mid-1970s, we have sought to identify shot that does not pose a significant hazard to migratory birds or other wildlife. Research has shown that ingested spent lead shot causes significant mortality in migratory birds. We first addressed the issue of lead poisoning in waterfowl in a 1976 Environmental Impact Statement, and later readdressed the issue in a 1986 supplemental EIS. The latter provided the scientific justification for a ban on the use of lead shot and the subsequent approval of steel shot for hunting waterfowl and coots that began in 1986, with a complete ban of lead for waterfowl and coot hunting in 1991. Since then, we have sought to consider other potential candidates for approval as nontoxic shot; we believe that other nontoxic shot should be made available for public use in hunting.

NEED FOR ACTION

Submission and evaluation of new shot types for approval as nontoxic is given at 50 CFR 20.134. The Fish and Wildlife Service is obligated to consider all such submissions. Steel, bismuth-tin, tungsten-iron, tungsten-polymer, tungsten-matrix, tungsten-nickel-iron, and tungsten-iron-nickel-tin shot are approved as nontoxic for use in hunting migratory birds. Many hunters believe that nontoxic shot does not compare favorably to lead and that it may damage some shotgun barrels, and a small proportion of hunters have not complied with nontoxic shot regulations. Allowing use of additional nontoxic shot types may encourage greater hunter compliance and participation with nontoxic shot requirements and discourage the use of lead shot. Increased use of nontoxic shot will enhance protection of migratory waterfowl and their habitats.

SCOPING AND PUBLIC PARTICIPATION

Under the regulations in 50 CFR 20.134, we are required to respond to applications for approval of new nontoxic shot types. This Draft Environmental Assessment will be published for public comment. We will respond to concerns about the TBI shot expressed in comments.

AUTHORITY AND RESPONSIBILITY

The Migratory Bird Treaty Act of 1918 (MBTA) implements migratory bird treaties between the United States and Great Britain for Canada (1916 and 1996 as amended), Mexico (1936 and 1972 as amended), Japan (1972 and 1974 as amended) and Russia (then the Soviet Union, 1978). They protect all migratory birds covered under any of the four treaties from take except as permitted under the MBTA. The regulatory authority for determining when, where, how, and by whom take of migratory birds can occur in the United States is vested in the Secretary, Department of the Interior. Under 50 CFR Part 20, the Secretary implements regulations for hunting migratory game birds.

BACKGROUND

The requirement to use nontoxic shot for hunting migratory birds created resistance in the hunting community to the use of steel shot, and some noncompliance with the requirement. The use of nontoxic shot for waterfowl hunting has increased in recent years (Anderson *et al.* 2000), but we believe that compliance will continue to increase with the availability and approval of other nontoxic shot types.

On November 18, 2003, we notified the public that International Nontoxic Composites of Ontario, Canada had applied for approval of Tungsten-Bronze-Iron shot as nontoxic for waterfowl hunting in the United States, and that the application for approval was complete (68 FR 65023 - 65024). We reviewed the shot under the criteria in Tier 1 of the revised nontoxic shot approval procedures contained in 50 CFR 20.134 for permanent approval of shot as nontoxic for hunting waterfowl and coots.

AFFECTED ENVIRONMENT

WATERFOWL POPULATIONS

The taxonomic family Anatidae, principally subfamily Anatinae (ducks) and their habitats, comprise the affected environment. Waterfowl habitats and populations in North America this year were described by the U.S. Fish and Wildlife Service (2003a).

In the Breeding Population and Habitat Survey for the traditional waterfowl survey area in North America (strata 1-18, 20-50, and 75-77), the total duck population estimate was 36.2 ± 0.7 (±1 standard error) million birds, 16% above the 2002 estimate of 31.2 ± 0.5 million birds ($P<0.001$), and 9% above the 1955-2002 long-term average ($P<0.001$). There were 7.9 ± 0.3 million mallards (*Anas platyrhynchos*) birds in the traditional survey area, a value similar to the 2002 estimate of 7.5 ± 0.2 million birds ($P=0.220$) and to the long-term average ($P=0.100$). Blue-winged teal (*anas discors*) were at 5.5 ± 0.3 million birds, 31% above the 2002 estimate of 4.2 ± 0.2 million birds ($P=0.001$) and 23% above the long-term average ($P=0.001$). Shovelers (*Anas clypeata*) at 3.6 ± 0.2 million (+56%) and pintails (*Anas acuta*) at 2.6 ± 0.2 million (+43%) were above their 2002 estimates ($P<0.001$). Gadwall (*Anas strepera*) at 2.5 ± 0.2 million, American wigeon (*Anas americana*) at 2.6 ± 0.2 million), green-winged teal (*Anas crecca*) at 2.7 ± 0.2 million, redheads (*Aythya americana*) at 0.6 ± 0.1 million, canvasbacks (*Aythya valisineria*) at 0.6 ± 0.1 million), and scaup (*Aythya marila* and *Aythya affinis*) at 3.7 ± 0.2 million were unchanged from their 2002 estimates ($P=0.149$). Gadwall (+55%) and shovelers (+72%) were above their long-term averages ($P<0.001$). Green-winged teal were at their second highest level since 1955, 46% above their long-term average ($P<0.001$). Pintails (-39%) and scaup (-29%) remained well below their long-term averages ($P<0.001$). American wigeon, redheads, and canvasbacks were unchanged from their long-term averages ($P=0.582$).

The total number of May ponds in Prairie Canada and the north-central U.S., at 5.2 ± 0.2 million, was 91% higher than in 2002 ($P<0.001$) and 7% above the long-term average ($P=0.034$). Canadian and U.S. ponds were 3.5 ± 0.2 and 1.7 ± 0.1 million respectively and both above 2002 (+145% and +30%. $P<0.001$). The number of ponds in Canada was similar to the 1961-2002 average ($P=0.297$), while U.S. ponds were 10% above their 1974-2002 average ($P=0.037$). The projected mallard fall flight index was 10.3 ± 0.9 million birds.

The 2003 total-duck population estimate for the eastern survey area, strata 51-56 and 62-69, was 3.6 ± 0.3 million birds. This was 17% lower than in 2002 (4.4 ± 0.3 million birds, $P=0.065$), but similar to the 1996-2002 average ($P=0.266$). Individual species estimates were similar to those from 2002 and to their 1996-2002 averages, with the exception of mergansers (0.6 ± 0.1 million), which decreased 30% from the 2002 estimate ($P=0.035$).

HABITATS

Waterfowl hunting occurs in habitats used by many taxa of migratory birds, as well as by aquatic invertebrates, amphibians and some mammals. Fish also may be found in many hunting locations.

ALTERNATIVES

Alternative 1: No Action. We would not authorize the use of TBI shot as nontoxic for hunting waterfowl and coots. This alternative would maintain the status quo by limiting the shot available to the hunting public to those currently approved for waterfowl hunting.

Alternative 2: Approval of TBI shot as nontoxic. This is the proposed action. We would approve TBI shot as nontoxic. Our approval would be based on the toxicological report, acute toxicity studies, reproductive/chronic toxicity studies, and other published research. The available information indicates that TBI shot is nontoxic when ingested by waterfowl and that it poses no significant danger to migratory birds, other wildlife, or their habitats.

CHARACTERIZATION OF TUNGSTEN-BRONZE-IRON SHOT

Tungsten-Bronze-Iron shot is an alloy of 51.1% tungsten by weight, 44.41% copper, 3.9% tin, and 0.6% iron. Its density in that formulation is 12.14 grams/cm^3. The shot also contains very small amounts of lead, molybdenum, phosphorous, and zinc, and tiny amounts of some other elements. The shot has no coating. It is not chemically or physically altered by firing from a shotgun. All of the primary metals are insoluble under hot and cold (Weast 1986). Neither manufacturing the shot nor firing shotshells containing the shot will alter the metals or increase their susceptibility to dissolving in the environment.

ESTIMATED ENVIRONMENTAL CONCENTRATIONS FOR TUNGSTEN-BRONZE-IRON SHOT

TERRESTRIAL ECOSYSTEM

Calculation of the estimated environmental concentration (EEC) of a candidate shot in a terrestrial ecosystem is based on 69,000 shot per hectare (50 CFR 20.134). For TBI shot, if the shot are completely dissolved, the EEC for tungsten in soil is 12.92 g/m^3. The EECs for copper, tin, and iron are 11.22, 0.99, and 0.15 g/m^3, respectively, in dry, porous soil. The EEC for tungsten from TBI shot is below that for tungsten-matrix shot. Tungsten is very rare, and is never found free in nature. The tungsten concentration in the earth's crust is estimated to be 1.5 parts per million. In conterminous U.S. soils, copper and tin are found at approximately 17 and 0.9 parts per million, respectively (Shacklette and Boerngen 1984). The EEC for copper is considerably below the U.S. Environmental Protection Agency (EPA) maximum for sludge to be applied in terrestrial settings. The concentration of tin is comparable to that found in U.S. soils. Iron is widespread in such settings, comprising approximately 2% of the composition of soils and sediments in the U.S. The EEC for iron from TBI shot is much lower than that level.

AQUATIC ECOSYSTEM

The EEC for water assumes that 69,000 #4 shot are completely dissolved in 1 hectare of water 1 foot (30.48 cm) deep. For TBI shot, the EEC for tungsten is 2.119 mg/l.

The value for copper is 1.842 mg/l. This EEC is approximately 153 times the EPA (2002) 12 µg/l 4-day average continuous concentration criterion for copper. It is about 635 times the 2.9 µg/l criterion for salt water.

The EEC value for tin in an aquatic setting is 0.162 mg/l. We found no EPA aquatic criterion for elemental tin.

The aquatic EEC for iron is 0.025 mg/l. The EPA water quality criterion for iron in fresh water is 1000 µg/l. EPA has set no criterion for salt water.

ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

ENVIRONMENTAL FATE

Elemental tungsten and iron are virtually insoluble in water, and therefore do not weather and degrade in the environment. Tungsten is stable in acids and does not easily form compounds with other substances. Preferential uptake by plants in acidic soil suggests uptake of tungsten when it has formed compounds with other substances rather than when it is in its elemental form (Kabata-Pendias and Pendias 1984). Elemental copper can be oxidized by organic and mineral acids that contain an oxidizing agent. Elemental copper is not oxidized in water (Aaseth and Norseth 1986). In water, tin is stable under ambient conditions.

TOXICOLOGICAL EFFECTS OF TUNGSTEN-BRONZE-IRON SHOT

MAMMALS

Tungsten. Tungsten may be substituted for molybdenum in enzymes in mammals. Ingested tungsten salts reduce growth, and can cause diarrhea, coma, and death in mammals (*e.g.* Bursian *et al.* 1996, Cohen *et al.* 1973, Karantassis 1924, Kinard and Van de Erve 1941, National Research Council 1980, Pham-Huu-Chanh 1965), but elemental tungsten is virtually insoluble and therefore essentially nontoxic. Tungsten powder added to the food of young rats at 2, 5, and 10% by mass for 70 days did not affect health or growth (Sax and Lewis 1989). A dietary concentration of 94 parts-per-million (ppm) did not reduce weight gain in growing rats (Wei *et al.* 1987). Exposure to pure tungsten through oral, inhalation, or dermal pathways is not reported to cause any health effects (Sittig 1991).

Tungsten salts are toxic to mammals. Lifetime exposure to 5 ppm tungsten as sodium tungstate in drinking water produced no discernible adverse effects in rats (Schroeder and Mitchener 1975). At 100 ppm tungsten as sodium tungstate in drinking water, rats had decreased enzyme activity after 21 days (Cohen *et al.* 1973).

Kraabel *et al*. (1996) surgically embedded tungsten-bismuth-tin shot in the pectoralis muscles of ducks to simulate wounding by gunfire and to test for toxic effects of the shot. The authors found that the shot neither produced toxic effects nor induced adverse systemic effects in the ducks during the 8-week period of their study.

Copper. Copper is a dietary essential for all living organisms. In most mammals, ingestion of one TBI shot pellet would result in release of 8 to 25 milligrams of copper, not all of which would be absorbed. In humans, ingestion of a TBI shot pellet could mobilize approximately 8 milligrams of copper, though again not all would be absorbed. These low levels of copper would not pose any risk to mammals. Copper poisoning due to ingestion of TBI shot is highly unlikely in most mammals.

Tin. Inorganic tin compounds are comparatively harmless; inorganic tin and its salts are poorly absorbed, their oxides are relatively insoluble, and they are rapidly lost from tissues (see Eisler 1989 for reviews).

Iron. Iron is an essential nutrient. Iron toxicosis in mammals is primarily a phenomenon of overdosing of livestock. Maximum recommended dietary levels of iron range from 500 ppm for sheep to 3000 ppm for pigs (National Research Council [NRC] 1980). The amount of iron in TBI shot would not pose a hazard to mammals.

BIRDS

Tungsten. Chickens given a complete diet showed no adverse effects of 250 ppm sodium tungstate administered for 10 days in the diet. However, 500 ppm in the diet reduced xanthine oxidase activity and reduced growth of day-old chicks (Teekell and Watts 1959). Adult hens had reduced egg production and egg weight on a diet containing 1,000 ppm tungsten (Nell *et al*. 1981). Ecological Planning and Toxicology (1999) concluded that the No Observed Adverse Effect Level for tungsten for chickens should be 250 ppm in the diet; the Lowest Observed Adverse Effect Level should be 500 ppm. Kelly *et al*. (1998) demonstrated no adverse effects on mallards dosed with tungsten-iron or tungsten-polymer shot according to nontoxic shot test protocols.

Copper. Copper requirements in birds may vary depending on intake and storage of other minerals (Underwood 1971). The maximum tolerable level of dietary copper during the long-term growth of chickens and turkeys is 300 ppm (Committee on Mineral Toxicity in Animals 1980). Eight-day-old ducklings were fed a diet supplemented with l00 ppm copper as copper sulfate for eight weeks. They showed greater growth than controls, but some thinning of the caecal walls (King 1975). Studying day-old chicks, Poupoulis and Jensen (1976) reported that no gizzard lining erosion could be detected in chicks fed 125 ppm of copper for four weeks, but they detected slight gizzard erosion in chicks fed 250 ppm copper. The authors found that it required 500 to 1000 ppm of copper to depress growth and weight gain of chicks. Jensen *et al*. (1991) found that 169 ppm copper in the diet produced maximal weight gain in chickens.

The influence of dietary copper addition on the body mass and reproduction of mature domestic chickens was analyzed by Stevenson and Jackson (1980). Hens fed on a diet containing 250 ppm copper for 48 days showed a similar daily rate of food intake as control hens (no copper in the diet). The mean number of eggs laid daily also did not differ between hens fed 250 ppm copper and controls. Negative affects on the daily food intake, body mass loss and egg laying rates were observed only at dietary copper levels in excess of 500 ppm, and after 4 months of being fed such diets.

Similar performance tests on growing domestic turkeys showed that 300 ppm copper in the daily diet produced no long-term effect on 1 week-old turkey poults, but 800 ppm of copper in the diet for three weeks inhibited growth (Supplee 1964). Vohra and Kratzer (1968) reported no effect of feeding 400 ppm of copper as copper sulfate to turkey poults in the daily diet for 21 weeks, and concluded that poults could tolerate 676ppm of copper without exhibiting deleterious effects. However, these authors reported reduced growth of poults fed 800 ppm and 910 ppm of copper over the same time, and death at 3240 ppm in the diet. This conclusion was supported by Christmas and Harms (1979), who found that copper in the diet of domestic turkeys had to rise to the 500- 750ppm level before signs of slight toxicity appeared, assuming that adequate methionine were also present.

Henderson and Winterfield (1975) reported acute copper toxicity in three-week- old Canada geese (*Branta canadensis*) that had ingested water contaminated with copper sulfate. The authors calculated the copper intake to be about 600 mg copper sulfate/kg body weight, or 239 mg Cu/ kg. The amount of copper released from 8 #4 shot would be 42.26 mg, which is much less that the 239 mg/kg toxic level.

Ingested copper shot does not increase mortality among mallards. Ducks dosed with eight #6 copper shot showed no toxic effects due to copper (Irby *et al*. 1967).

<u>Tin</u>. Reviews indicate that elemental tin is not toxic to birds (Cooney 1988, Eisler1989). Tin shot designed for waterfowl hunting is used in several European countries. We are aware of no reports that suggest that tin shot causes toxicity problems for wildlife.

Grandy *et al*. (1968) and the Huntingdon Research Centre (1987) conducted 30-day and 28-day, respectively, acute toxicity tests on mallard ducks by placing tin pellets inside the digestive tract or tissues of ducks. They reported that all treated ducks survived without deleterious effects.

Ringelman *et al*. (1993) conducted a 32-day acute toxicity study which involved dosing game-farm mallards with a shot alloy of 39% tungsten, 44.5% bismuth, and 16.5% tin (TBT shot) by weight, respectively. All the test birds survived and showed normal behavior. They suffered no tissue toxicity or damage.

As noted for tungsten, Kraabel *et al*. (1996) imbedded TBT shot in muscles of ducks for an 8-week study. They determined that the shot neither produced toxic effects nor induced any adverse systemic effects on the health of the ducks.

The 2% tin in bismuth-tin (BT) shot produced no toxicological effects in ducks during reproduction. It did not affect the health of ducks, the reproduction by male and female birds, or the survival of ducklings over the long term (Sanderson *et al*. 1997).

In a 30-day dosing study using game-farm mallards dosed with eight #4 size tin shot, there were no overt signs of toxicity or treatment-related effects on body weight. Tin was not detected in any tissues (Gallagher *et al*. 1999).

Based on the toxicological report and the toxicity tests for tin shot, we concluded that tin shot, which was approximately 99.9 percent tin by weight, posed no significant danger to migratory birds or other wildlife and their habitats (Federal Register 65 (236):76885-76888). We believe the small amount of tin in TBI shot is not likely to harm waterfowl.

TBI shot will rapidly be broken up and dissolved in the gizzard if ingested by waterfowl. TBI shot disintegrated completely in less than 14 days under chemical action alone, according to data submitted by INC. The INC submission also asserted that "action of the gizzard assisted by grit would cause complete fragmentation in a much shorter time, probably less than one week. Moreover, the fine pieces of shot that are released in a gizzard would quickly leave the gizzard, so lowering the overall dissolution of copper."

Ingestion of TBI shot by waterfowl would subject the shot to low pH and grinding in the gizzard. Based on an *in vitro* simulation, INC concluded that ingestion of eight #4 TBI shot (1.39 g) would release a maximum of 42.26 mg of copper each day for one week or less. In a diet of 150 g of dry food, that release is equivalent to 281.7 ppm copper. In young chickens, 500 ppm or more reduced body growth when ingested for one month (Poupoulis and Jensen 1976). Stevenson and Jackson (1980) determined that adult chickens suffered negative effects of copper ingestion only at dietary levels in excess of 500 ppm for four months. Copper toxicosis in young Canada geese (*Branta canadensis*) was triggered by ingestion of water that contained approximately 239 mg/kg of body weight (Henderson and Winterfield 1975).

INC also suggested that "The Tungsten-Bronze-Iron shot will also liberate iron ions at the same time that copper is being dissolved in the gizzard. The iron in solution could moderate the uptake of copper from the small intestine of the bird (see Davis and Mertz 1987)."

<u>Iron</u>. Chickens require at least 55 ppm iron in the diet (Morck and Austic 1981). There were no ill effects on chickens fed 1,600 ppm iron in an adequate diet (McGhee *et al*. 1965). Turkey poults fed 440 ppm in the diet suffered no adverse effects. The tests, in which 8 #4 tungsten-iron shot were administered to each mallard in a toxicity study indicated that the 45% iron content of the shot had no adverse effects on the test animals (Kelly *et al*. 1998).

OTHER ENVIRONMENTAL ISSUES

We have previously approved as nontoxic other shot types that contain tungsten, iron, and tin. Previous assessments of tungsten-iron, tungsten-polymer, tungsten-matrix, and tungsten-nickel-iron shot indicated that neither the tungsten nor the iron in TBI shot should be of concern in aquatic systems. Similarly, release of tin and iron from TBI shot should not harm aquatic or terrestrial systems. It is generally agreed that inorganic tin and tin compounds are comparatively harmless (Eisler 1989). The release or iron from the shot would be insignificant in natural settings. Reviews of past studies for approvals of other tungsten-based nontoxic shot types also support the idea that ingestion of TBI shot will not cause harm to birds or mammals. We have no concerns about approving an additional shot that contains these metals.

However, the 1.842 mg/l EEC for copper from TBI shot calculated for Tier 1 review is considerably greater than the EPA criteria for both fresh water and salt water. Though the Tier 1 EEC is a “worst-case” preliminary evaluation of possible effects of the components of a proposed nontoxic shot type, the determination of the aquatic EEC suggested that evaluation of the release of copper from TBI shot and the resultant effects on aquatic biota is warranted.

To determine the actual release of copper from TBI shot, Tin Technology, Ltd. and ITRI Ltd. of the United Kingdom conducted *in vitro* tests of the shot in synthetic buffered waters with pHs of 5.6, 6.6, and 7.8 at 15° C over 28 days. Under normal pH conditions, TBI shot is very sparingly soluble, and the tests demonstrated that copper release from TBI shot is minimal. INC reported that “5 shot would be required in 1 liter quantities of moderately hard water to generate sufficient concentrations of dissolved copper to be detectable in the leaching tests.” The concentrations in water for a single shot calculated from the 28-day leaching tests are shown in Table 1. These concentrations are quite low; essentially the equivalent of background values.

From the copper concentrations under the three pH conditions, the risk to aquatic organisms due to use of TBI shot can be evaluated (50 CFR 20.134 (b)(2)(i)(D)(2). The risk of the submitted shot material is determined by comparing the EEC to an appropriate toxicological level of concern - in this case EPA LC50 values for the most sensitive aquatic organisms. *Ceriodaphnia reticulata* have the lowest average LC50 listed, 9.92 µg/l. The ratio of the EEC to the LC50 for this species (using the EEC for pH 5.6) is (0.4136/9.92), or 0.042. Under the guidelines in (50 CFR 20.134 (b)(2)(i)(D)(2), a risk ratio quotient less than 0.1 indicates that detrimental effects on aquatic organisms are not likely. For TBI shot, even under acidic conditions the risk ratio is only about 4% of the effect level. Thus, we conclude that negative effects from approval of TBI shot are very unlikely.

Table 1. Copper concentrations in water over the duration of dissolution testing of Tungsten-Bronze-Iron shot.

Day	Mean [Cu] (µg/l)	Standard Deviation (µg/l)
	pH 5.6	
0	0.0070	0.0076
7	0.2936	0.0310
14	0.3340	0.0391
21	0.3827	0.0392
28	0.4136	0.0393

Day	Mean [Cu] (µg/l)	Standard Deviation (µg/l)
	pH 6.6	
0	0.0036	0.0066
7	0.0679	0.0143
14	0.0851	0.0123
21	0.1158	0.0212
28	0.1261	0.0190

Day	Mean [Cu] (µg/l)	Standard Deviation (µg/l)
	pH 7.8	
0	0.0056	0.0073
7	0.0047	0.0077
14	0.0105	0.0077
21	0.0310	0.0062
28	0.0233	0.0165

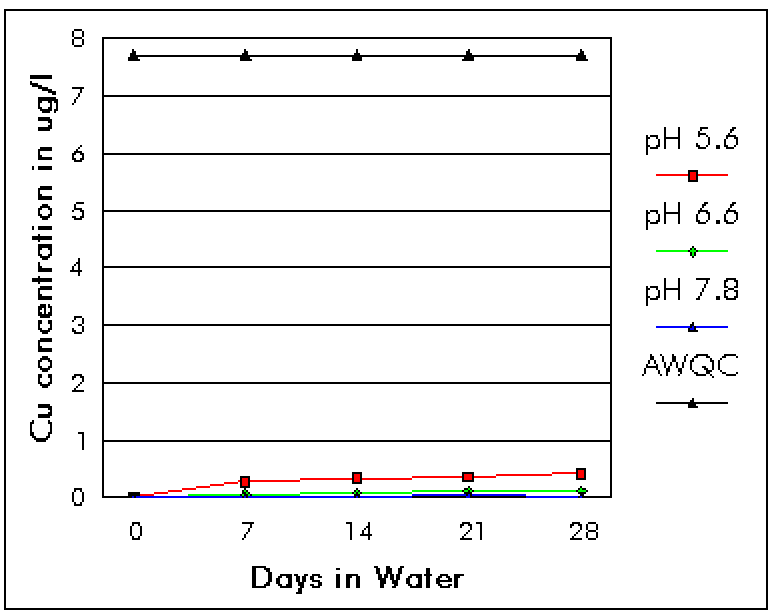

Figure 1. Comparison of dissolved copper concentrations from one TBI shot in one cubic foot of water, and different pH levels and EPA chronic ambient water quality criterion (AWQC) for water at the hardness in the dissolution test.

IMPACTS OF THE "NO ACTION" ALTERNATIVE

Migratory Waterfowl. The status quo would be maintained by not authorizing use of TBI shot for hunting waterfowl and coots. By regulation, steel, bismuth-tin, tungsten-iron, tungsten-polymer, tungsten-matrix, tungsten-nickel-iron, and tungsten-iron-nickel-tin are the only nontoxic shot types authorized for use by waterfowl and coot hunters. Because these shot types have been shown to be nontoxic to migratory birds, using only those shot types would have no adverse impact on waterfowl and their habitats. Test results on the toxicity of TBI shot and analyses of its likely effects on migratory birds indicate that it too is nontoxic. We are concerned, however, because some nontoxic shot types are not widely used, and steel is unacceptable to a percentage of waterfowl hunters. Without alternative nontoxic shot types, hunters may not comply with the requirement for use of nontoxic shot when hunting waterfowl. The hunters who still consider steel an unacceptable alternative might continue to use lead, resulting in a small negative impact to the migratory bird resource. Use of lead shot would also negatively impact wetland habitats because of shot erosion and the ingestion of shot by aquatic animals. We are concerned about noncompliance, but we believe that the no action alternative would have only a small negative impact on the resource.

Endangered and Threatened Species. The impact on endangered and threatened species of "no action" should be minimal. We obtain a biological opinion pursuant to Section 7 of the Endangered Species Act prior to establishing the seasonal hunting regulations. The hunting regulations promulgated as a result of this consultation remove and alleviate chances of conflict between migratory bird hunting and endangered and threatened species. We also will consult on effects on threatened and endangered species concurrent with the approval of TBI shot.

Our consultations do not address take resulting from noncompliance. Indeed, a factor considered when we developed the regulations banning the use of lead for migratory waterfowl hunting was the impact of lead on endangered and threatened species. hunter failures to comply with the existing ban on lead are of concern to us. If additional alternatives to lead shot are not available, small amounts of lead shot may be added to the environment, causing a negative impact on endangered and threatened species. We believe noncompliance is of concern, but the "no action" alternative would have only a small negative impact on the resource.

Ecosystems. Steel, bismuth-tin, tungsten-iron, tungsten-polymer, tungsten-matrix, tungsten-nickel-iron, and tungsten-iron-nickel-tin nontoxic shot types are permanently authorized for use by waterfowl and coot hunters. Because those shot types have been shown in test results to be nontoxic to the migratory bird resource, we assume that they cause no adverse impact on ecosystems. There is concern, however, about noncompliance and potential ecosystem effects. The use of lead shot has a negative impact on wetland ecosystems due to the erosion of shot, causing sediment/soil and water contamination and the direct ingestion of shot by aquatic and predatory animals. Though we believe noncompliance is of concern, the "no action" alternative would continue to have only a small negative impact on the resource.

Socioeconomic Issues. In the 2002-2003 hunting season there were approximately 1.38 million active waterfowl hunters (U.S. Fish and Wildlife Service 2003b). There is concern that a small percentage of this hunting public finds some nontoxic shot to be unacceptable, but also ceased using lead when they became aware of its toxic properties. Factors unrelated to the availability of nontoxic shot (such as framework regulations, hunting success, availability of birds, hunting sites, weather, and habitat) probably have a much greater impact on hunter participation, and therefore on the socioeconomic environment. Capital expenditures (such as purchases of shotguns) likely are more affected by hunter numbers. The alternative of "no action" would contribute to fewer numbers of hunters and result in less financial support for hunting-supported retail businesses and less money available to public management programs. This is a minor negative impact on socioeconomic conditions.

The "no action" alternative would have a major negative impact on those who invested in the development and marketing of TBI shot. In isolated instances this impact would be major, but to the overall migratory bird hunting culture, impact would be minor. Total economic value of waterfowl hunting only represents a negligible portion of the national product. Also, if a shot material is considered with some level of confidence to be nontoxic and otherwise not a danger to the environment, non-approval would have a negative socioeconomic impact by restricting the development of new businesses and markets.

IMPACTS OF APPROVAL OF TUNGSTEN-BRONZE-IRON SHOT AS NONTOXIC

Migratory Waterfowl. Furnishing another approved nontoxic shot will likely result in a minor positive long-term impact on waterfowl and wetland habitats. Approval of TBI shot as nontoxic would have a positive impact on the waterfowl resource.

Endangered and Threatened Species. The impact of this alternative on endangered and threatened species is similar to that described for waterfowl. In the short- and long-term, this alternative would provide a positive impact on endangered and threatened species by assuring that TBI shot has been found nontoxic. Also, as an alternative shot, it will further discourage the use of lead during waterfowl hunting and perhaps extend to upland game.

Ecosystems. Approval of TBI shot as nontoxic would have a short-term positive impact on ecosystems. Some hunters still shooting lead shot may switch to TBI shot. Approval of an additional nontoxic shot type will result in positive long-term impact on ecosystems.

Socioeconomic Issues. In the short- and long-term, a minor positive impact will result by approving TBI shot as an alternative to other approved nontoxic shot types. People who may have stopped hunting might be encouraged to participate again, and businesses could experience increased activity. Funding support for public programs will increase and product manufacturers will be able to target potential markets.

COMPARISON OF EFFECTS

Impacts	Alternative 1	Alternative 2
Migratory Waterfowl	No Impact	Minor Short- and Long-term Positive Impacts
Endangered and Threatened Species	No Impact	Minor Short- and Long- term Positive Impacts
Socio/Economic	No Impact	Minor Short- and Long-term Positive Impacts

CUMULATIVE IMPACTS

We foresee no negative cumulative impacts of approval of TBI shot for waterfowl hunting. Approval of an additional nontoxic shot type should help to further reduce the negative impacts of the use of lead shot for hunting waterfowl and coots.

TRANS-BOUNDARY EFFECTS

We believe the impacts of approval of TBI shot for waterfowl hunting should be positive both in the United States and elsewhere. Approval of an additional nontoxic shot type should help to further reduce lead poisoning of waterfowl that migrate south of the U.S. for the winter and of animals that prey on them or consume their carcasses.

CONSULTATION, COORDINATION, AND COMMENTS

We will make this Environmental Assessment available for public comment for 30 days. We will respond to all agency and private comments on the proposal to approve TBI shot as nontoxic for hunting waterfowl.

Preparer

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